



Construction of Depositional Paleoenvironment of the Biafra Member Sediments of Agbada Formation of Eb-7P Well in Ebb Field, Eastern Shallow Offshore, Niger Delta, Nigeria

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Abstract

This study documents the foraminifera and palynomorphs content and constructs the depositional paleoenvironment of the analyzed interval of the field. Ditch cutting samples collected from 3780ft to 6320ft of well EB-7P in EBB field, Southeastern Niger Delta have been analyzed for their foraminiferal and palynomorphs content using standard procedures with a bid to presenting a template for resolving age and facies correlation difficulties typical of this part of the Delta. The samples from 3780ft to 5260ft of the well yielded moderate to good foraminifers, while 5260ft to 6320ft was barren. Twenty-one foraminiferal species comprising 71% calcareous benthics, 23% planktic suite and 6% arenaceous benthics constrained the analyzed interval to an F-zone of N¹⁷. The interval is of Late Miocene age based on the occurrence of *Uvigerina peregrina*, *Quinqueloculina seminulum*, *Q. vulgaris* and *Amphistegina lessonia* as well as the single occurrence of the planktic species: *Sphaeroidinellopsis seminulina* at 3900ft. Analyzed samples were correlated to a P800 zone subdivided into P850 and P860 subzones belonging to the *Echitricolporites spinosus* pantropical zone. Ditch cutting samples investigation show presence of sandstone, siltstone and shale of varying proportion at different depths. The sediments have been suggested to be deposited within coastal-deltaic settings.

Keywords: Biostratigraphy, Palynomorphs, Foraminifera, Miocene, Benthic, Niger Delta.

Introduction

Situated between latitudes 4⁰ and 6⁰ N and longitudes 3⁰ and 9⁰ E is the prolific Niger Delta (Fig. 1), a gently sloping wedge that spans along a delta plain through shelf to slope. Hydrocarbon exploration has

over the years drifted from more mature, less complex onshore sections of the Delta to the more challenging deeper frontier parts of the basin. In line with this transition, research interest is also extended towards better understanding of the basin in a bid to offer more innovative and cost effective ways of field

development. Some of the studies in this region can be found in Weber and Daukoro (1975), Beka and Oti (1995), Ozumba and Amajor (1999) and Nwajide (2013).

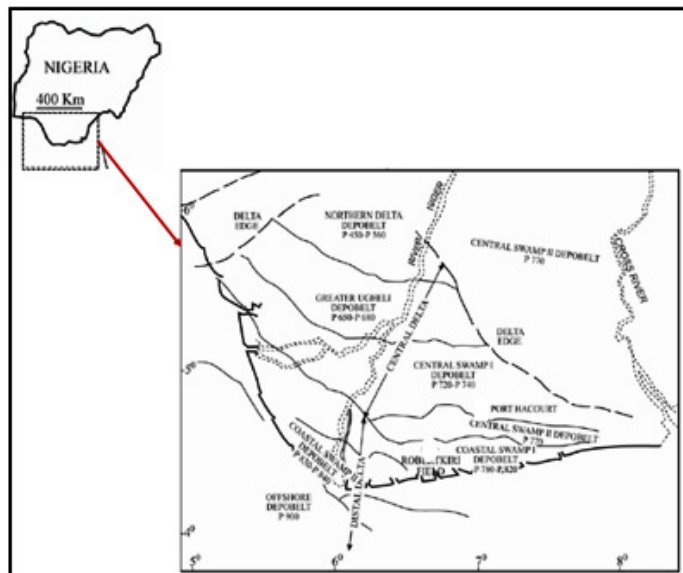


Fig. 1. Location of the Niger Delta, Nigeria (Modified from Doust and Omatsola, 1990).

Exploration successes in the Niger Delta are closely knit to accurate delineation and age-dating of biostratigraphic events as this has enabled correlation within and across fields and basins. Haq et al., (1988), Mebradu (2000), Oloto (1994) and Obaje and Okosun (2013) among others are a few examples of vital biostratigraphic guides of the Niger Delta. In spite of a fairly rich resource of biostratigraphic research and documentations across the Niger Delta, lots of age and correlating problems still pervade the basin especially at the eastern part of the Delta.

Ebb field is located in the southeast offshore section of the Niger Delta (Fig.2), which has been considered to have a slightly different petroleum geological setting from other onshore and offshore parts of the basin. Its complex structural framework is as a result of deep-seated shale deformation and associated faulting (Akinosho, 1997). The configuration has huge influence on the preservation of biofacies thereby making their investigation difficult.

This study therefore documents findings of foraminiferal and palynomorph investigation carried out on ditch cutting samples collected from between 3780ft MD and 6230ft MD of Well EB-7P. The results were used to generate a high resolution biostratigraphic framework and construct the depositional paleoenvironment for the sediments in the field as well as correlate interpreted bioevents to the Niger Delta Cenozoic Chronostratigraphic Chart of Haq et al. (1988).

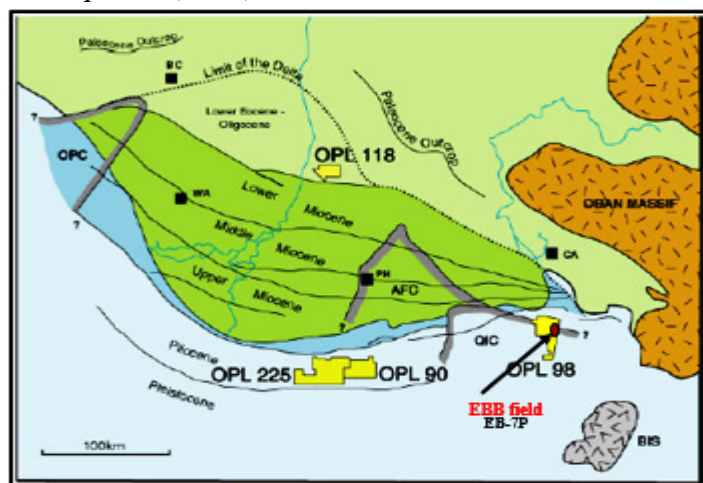


Fig. 2. Map showing field location (Modified from Clark et al., 2000).

Methodology

A total of 43 ditch cutting samples were collected at 60ft interval between 3780ft and 6230ft of well EB-7P. The samples were recorded according to depth after which 20 grams each was prepared for palynomorph and foraminiferal analysis, and results can be found in Figures 3 and 4.

For palynological analysis, each sample was treated first with Hydrochloric acid (HCl), then Hydrofluoric acid (HF) for the dissolution of carbonates and silicates respectively. Fluoride gels were then removed using 36% HCL and thoroughly washed with distilled water. Organic content separation was achieved using centrifuge process after samples were treated with 0.5% HCl and Zinc bromide in 15cc centrifuge tubes. Oxidation of the organic residue using Nitric acid (HNO₃) was followed by

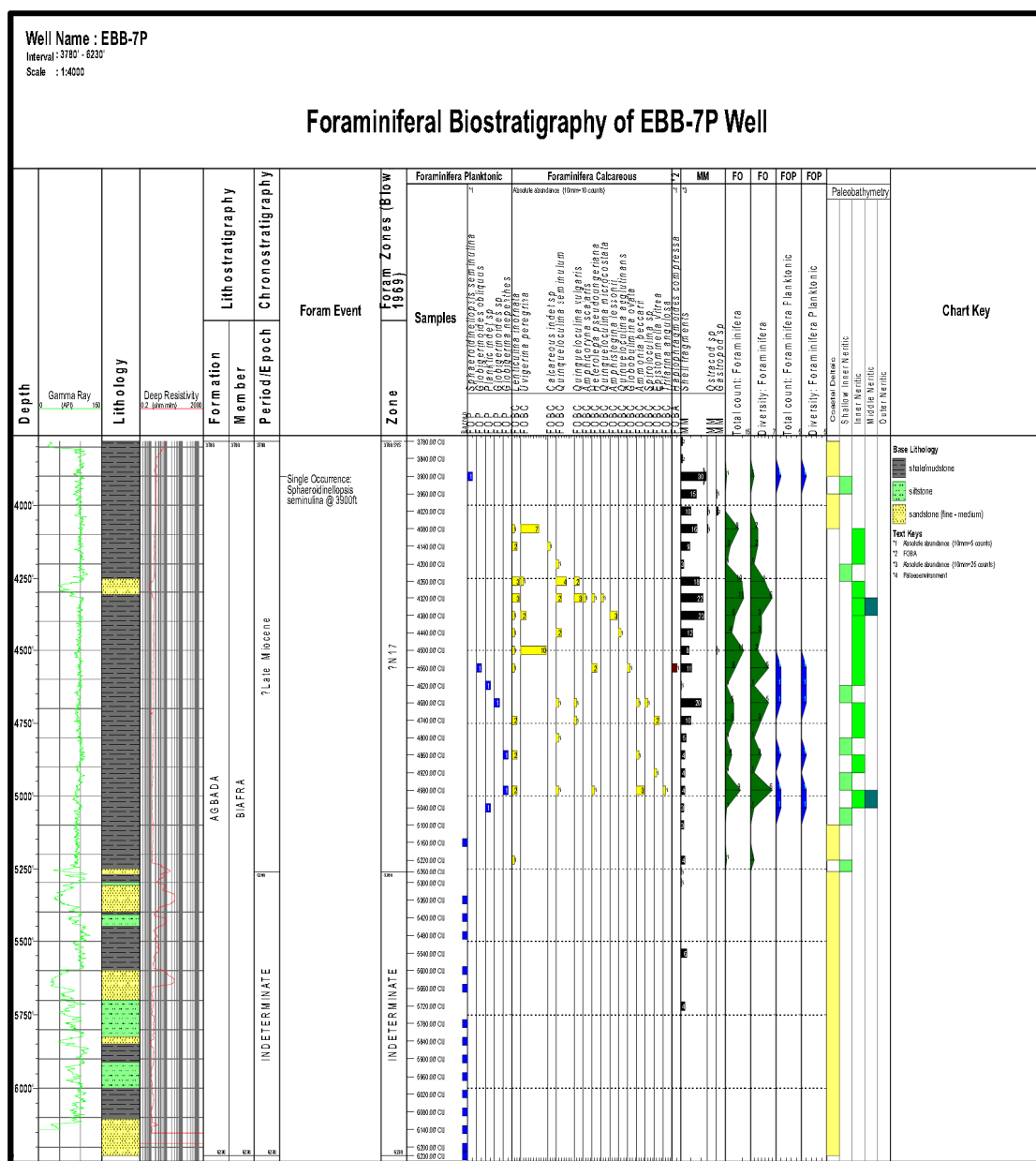


Fig.3. Foraminiferal chart for well EB-7P.

neutralization using Potassium hydroxide (KOH) and then washed with alcohol. A drop of Glycerin ensured that the residues were well preserved for the preparation and mounted on well labeled glass slides. A zonation scheme of Evamy et al., (1978) was adopted.

For foraminiferal analysis, the samples were first washed to remove mud and dried. The composited 20g samples were then treated with a tablespoonful

each of anhydrous Sodium Carbonate for thorough disintegration and washed. Drying was done at 20°C after which the samples were separated into coarse, medium and fine fractions then stored in labeled sample bags. Picking of fossils was then done using a light binocular Zeismicroscope. The species were identified using standard foraminiferal photomicrographs of Petters (1982), while the approach by Blow (1979) as incorporated in Bolli and Saunders (1985) was adopted.

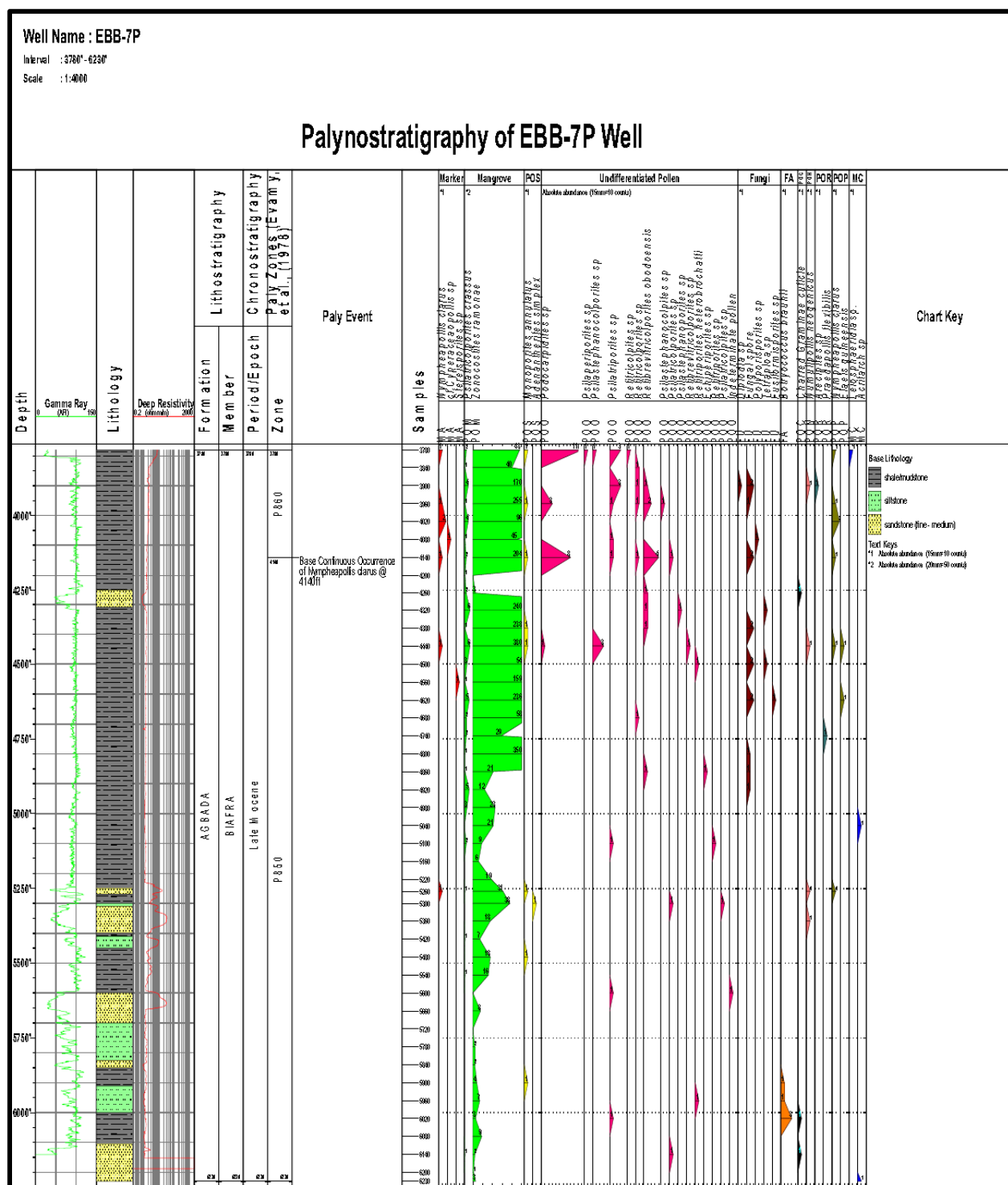


Fig.4. Palynomorphs chart for well EB-7P.

Results and Discussion

Foraminifera analysis

Twenty-one foraminiferal species were identified using standard foraminiferal photomicrographs such as Petters (1982) and Bolli and Saunders (1985). Analyzed samples from 3780ft to 5260ft of the well

yielded low to moderately high amounts of diverse foraminifers while samples from 5260ft to 6230ft of the well were entirely empty of foraminifera (Table 1). The recovered foraminifera were identified to species level where possible, with their abundance recorded. Details of foraminiferal occurrence in the analyzed interval include approximately 71% calcareous benthic taxa consisting of *Lenticulina inornata*, *Uvigerina peregrina*, *Quinqueloculina seminulum*, *Q. vulgaris*, *Q. microcostata*, *Q. agglutinans*, *Amphicorynascalaris*, *Amphistegina lessonii*, *Heterolepa pseudoungerina*, *Ammonia beccarii*, *Globobulimina ovata*, *Spiroloculina* sp. and *Epistominellavitrea* associated with approximately 5% arenaceous benthics of mainly *Haplophragmoides compressa*. The benthic assemblage is complemented by a 23% planktic suite that consists of *Sphaeroidinellopsis seminulina*, *Globigerinoides obliquus*, *Globigerinoides* sp. and *Globigerina nepenthes*.

Table 1. Foraminiferal summary of well EB-7P

Interval(ft)	F-Zone (after Blow, 1979)	Remark
3780-5260	N17	Single occurrence of <i>Sphaeroidinellopsis seminulina</i> at 3900ft
5260-6230	Indeterminate	Interval completely barren of Foraminifera

A checklist, with the stratigraphic interpretations are plotted on a chart generated using the STRATABUGS software (Fig.3).

The Foraminiferal biozonation of the well aligns with the approach by Blow (1979) as adopted in Bolli and Saunders (1985). This shows that sediments penetrated by EB-7P are within one foraminiferal

zone (F-Zone) identified as a probable? N17 of Late Miocene. The Late Miocene age interpreted for this interval is based on the occurrences of *Uvigerina peregrina*, *Quinqueloculina seminulum*, *Q. vulgaris* and *Amphistegina lessonias* well as the single occurrence of the planktic species: *Sphaeroidinellopsis seminulina* at 3900ft. The benthic assemblage as recorded is consistent with Late Miocene to Pliocene (Petters, 1982). The single occurrence of the planktic taxon is indicative of the penetration of an F-Zone not older than the N17, Late Miocene microzone (Blow, 1979; Bolli and Saunders, 1985). Also, the last downhole occurrence (LDO) of this taxon marks the base of the N17 microzone (Bolli and Saunders, 1985).

Palynomorphs analysis

Palynomorph preservation on the other hand is relatively good with analyzed samples yielding fair to rich assemblages of miospores. The recovery of marine indicator palynomorphs throughout the entire analyzed section was however very poor.

The analyzed samples were correlated to a palynological zone, P800 using the zonation scheme of Evamy et al.(1978) and subdivided into P860 and P850 based on their palynofloral characteristics. These two subzones belong to the *Echitricolporites spinosus* pantropical zone of Germeraad et al. (1968) and also plotted in a chart (Fig.4).

The P860 event zone delineated from 3780ft to 4180ft is marked by a base continuous occurrence of *Nympheapollis clarus* at 4140ft. The upper limit of this subzone was not encountered since the occurrence of *Retistephanocolpites gracilis* was not reached within this interval. Characteristic occurrences within this zone consists of mangrove pollen (*Zonocostites ramonae*), moderate occurrences of *Nympheapollis clarus*, *Psilastephanocolporites laevigatus*, *Pachydermites diderixi* and

Retibrevitricolporites obodoensis, fairly low occurrence of *Striatricolporites catatumbus*, and the presence of *Cyperceapollis* spp. and *Aletesporites* spp. in association with moderate *Monoporites annulatus*.

The top of the P850 event zone at 4140ft to 6230ft of the well coincides with the base of the overlying P860 is marked by the base continuous occurrence of *Nympheapollis clarus*. The base of this zone, which should have been defined by the quantitative top occurrence of *Peregrinipollisnigericus* could not be delineated because this event was not encountered, it is considered to be below the total depth of the well.

Characteristic microfloral markers of P860 Zone include the scarce occurrence of *Nympheapollis clarus*, low occurrence of *Retibrevitricolporites obodoensis*, *Stereoisporites* spp and *Magnastriatites howardi*, moderate *Pachydermites diderixi*, very high to moderate occurrence of mangrove taxa; *Zonocostites ramonae* and *Psilatricolporites crassus* in association with low occurrence of marine fossils.

Depositional Paleoenvironment

Lithologic analysis of the ditch cutting samples shows presence sandstone, siltstone and shale occurring in varying proportions at different depths of the well. The upper section (3780ft-5260ft) of the well has shale as the dominant lithofacies except for 3780ft to 4180ft where sandstone dominated. The depth zone from 5260ft to 6230ft of the well has dominant sandstone with minor siltstone and shale intercalations.

Sediments between 4310ft and 4980ft are deposited predominantly in inner neritic environment as evidenced by the high occurrence of *Zonocostites romonae* and fresh water swamp pollen, low *Monoporites annulatus* and low pteridophyte spores. On the other hand, sediments between 4980ft and 5260ft are deposited between coastal deltaic through inner to middle neritic bathymetric realms because of

the moderate occurrence of *Zonocostites romonae*, low freshwater swamp pollen, very low *Monoporites annulatus* and freshwater algae as well as rare marine indicator palynomorphs.

Also, 5260ft to 6230ft very low to low *Zonocostites romonae* and fresh water swamp pollen, anomalously low *Monoporites annulatus* and freshwater algae as well as rare marine indicator palynomorphs. This interval is completely barren of foraminifera, an occurrence that is associated with very high sedimentation rate, variations in salinity and temperature which are typical of estuaries, tidal flats and marginal marine environments.

Conclusion

Foraminiferal and Palynomorphic analysis carried out on 48 ditch cutting samples collected between 4130ft and 6320ft of well EB-7P has shown that Biafra member sediments in the well in EBB field penetrated one foraminiferal zone identified as a probable? N17 of Late Miocene with the occurrences of *Uvigerina peregrina*, *Quinqueloculina seminulum*, *Quinqueloculina vulgaris* and *Amphistegina lessonias* well as the single occurrence of the planktic species: *Sphaeroidinellopsis seminulina* at 3900ft and a P800 zone subdivided into P850 and P860 based on palynofloral characteristics. Ditch cutting samples investigation has shown presence of sand, siltstone and shale deposited in coastal deltaic, inner to middle neritic and marginal marine environments. This study has improved biostratigraphic resolution through the application of foraminiferal and palynomorph analysis in the delineation of the Biafra member sediments.

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